

August 24, 2011

Ms. Carla Suszkowski
Range Resources-Appalachia LLC
380 Southpointe Blvd.
Canonsburg, Pennsylvania 15317

Dear Ms. Suszkowski:

Subject: Gas Seep Sampling Results
Yeager Property
McAdams Road, Washington County, Pennsylvania
CEC Project 111-147

Civil & Environmental Consultants, Inc. (CEC) presents this letter report documenting the sampling and results of two gas seep samples collected from the Yeager property.

1.0 BACKGROUND AND PURPOSE

On July 13, 2011, you called CEC indicating Range Resources and the Pennsylvania Department of Environmental Protection (PADEP) visited property owned by the Yeager family in response to a resident's report that some type of gas was apparently emanating from the ground near a small stream. It is our understanding the PADEP opined the gas likely was methane and microbial in origin. During our call, you requested that CEC sample the unidentified gas. The purpose of the sampling was to determine if the gas emanating from the seep was methane and, if so, whether the methane was thermogenic or microbial in origin.

2.0 SAMPLE COLLECTION AND RESULTS

On July 14, 2011, CEC collected two gas samples from the Yeager property. CEC's sampler was accompanied by Mr. Mark Kiel of Range Resources. The samples were collected from two punch holes that were being observed as a result of the landowner's report to PADEP.

Each gas sample was collected in a 0.3 liter Cali-5-Bond Gas Bag using flexible tubing and a hand pump. The samples were shipped under chain-of-custody to GeoMark Research of Lafayette, Louisiana for analysis of gas composition and stable carbon and hydrogen isotopes.

The analytical results are presented in the attached laboratory report from GeoMark Research. The laboratory report includes a crossplot of the carbon and hydrogen isotopes of methane in the samples.

3.0 DISCUSSION

Methane can be divided into two general genetic classes: microbial and thermogenic. Microbial methane, which is also referred to as biogenic methane, is the product of the anaerobic decomposition of organic material. Two processes dominate the production of microbial methane. One is acetate fermentation, which is the dominant process that produces near-surface methane such as swamp gas and landfill gas. The second is carbon dioxide reduction, which dominates the production of drift gas where organic materials have been covered by glacial drift deposits. Carbon dioxide reduction can also account for some methane generated in coal seams under certain conditions. Thermogenic gas is formed by the breakdown of organic material by high temperatures and pressures in deep burial environments. Thermogenic gases are associated with natural gas present in bedrock formations and include coal bed methane.

Gas composition can often provide a clue to differentiate a gas as thermogenic or microbial in origin. High concentrations of heavier hydrocarbons (ethane, propane, butane, etc.) are only associated with thermogenic gases. Microbial gases are comprised primarily of methane because bacteria do not produce significant concentrations of ethane, propane, or butane. However, low concentrations of these heavier hydrocarbons do not prove a gas is thermogenic in origin.

Isotopic analysis can generally distinguish thermogenic from microbial gases. Typically, this is done by plotting values of the carbon and hydrogen isotopes of methane in comparison with the normal isotopic ranges of thermogenic, near-surface microbial, and sub-surface microbial gases developed by Dr. Dennis Coleman and others in 1993.

Radiocarbon dating can also be used to determine if methane is thermogenic or microbial. Thermogenic methane will not contain measurable amounts of ^{14}C because the gases formed from organic materials that are much greater than 50,000 years old, which is the limit of radiocarbon dating. Microbial gases will contain measurable concentrations of ^{14}C because the gases formed from much younger organic material.

4.0 OPINION

The attached laboratory report from GeoMark Research summarizes the gas composition and isotopic results for the two gas samples collected by CEC (Yeager #1 and Yeager #6). The compositional analysis for the sample collected from the punch hole identified as Yeager #1 indicates the gas is comprised primarily of a mix of ambient air, carbon dioxide and methane. The sample from Yeager #6 appears to be comprised mostly of ambient air with elevated concentrations of carbon dioxide and methane.

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The isotopic results for the methane in the two samples collected from the Yeager property, as documented and plotted in the attached laboratory report, confirm the methane resembles microbial gas formed by acetate fermentation in a shallow environment.

5.0 CLOSING

CEC greatly appreciates this opportunity to work with you on your project. Please call if you have any questions or comments.

Sincerely,

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.

Mark Orzechowski, P.G.
Project Manager

James P. Nairn, P.G.
Senior Vice President

Enclosure

111-147-LR-Gas Seep-8-24-11/P



Gas Analyses Report

**Yeager Property
Amwell Township, PA**

Civil & Environmental Consultants, Inc.

July 15, 2011

115 Zanolite Street
Lafayette, LA 70508
337.261.4002

GEO MARK RESEARCH, LTD.

9748 Whithorn Drive
Houston, TX 77095
281.856.9333



GAS COMPOSITION AND ISOTOPE ANALYSES

GEOMARK RESEARCH, LTD.

Yeager Property, PA

Gas Analyses

Sample ID						Stable Carbon Isotopes			
Well ID Number	Sample Depth (ft)	Sampling Date	Sampling Time	Tubing Pressure (psia)	Casing Pressure (psia)	$\delta^{13}\text{C}$ Methane (‰)	$\delta^{13}\text{C}$ Ethane (‰)	$\delta^{13}\text{C}$ Propane (‰)	δD Methane (‰)
Yeager #1						-44.3	-34.3	-34.6	-314
Yeager #6						-44.3	-34.4	-34.3	-319

Complete Gas Composition												
Well ID Number	N ₂ / Air Conc. (mole %)	CO ₂ Conc. (mole %)	H ₂ S Conc. (mole %)	C ₁ Conc. (mole %)	C ₂ Conc. (mole %)	C ₃ Conc. (mole %)	iC ₄ Conc. (mole %)	nC ₄ Conc. (mole %)	iC ₅ Conc. (mole %)	nC ₅ Conc. (mole %)	C ₆ + Conc. (mole %)	Specific Gravity (Air = 1.0)
Yeager #1	49.04	34.17	0.00	16.56	0.11	0.07	0.01	0.03	0.00	0.00	0.00	1.089
Yeager #6	99.35	0.43	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.969

Hydrocarbon Gas Composition									Calculated Ratios		
Well ID Number	C ₁ Conc. (mole %)	C ₂ Conc. (mole %)	C ₃ Conc. (mole %)	iC ₄ Conc. (mole %)	nC ₄ Conc. (mole %)	iC ₅ Conc. (mole %)	nC ₅ Conc. (mole %)	C ₆ + Conc. (mole %)	Wetness C ₂ + (mole %)	C ₁ /C ₂ Ratio (mole/mole)	iC ₄ /nC ₄ Ratio (mole/mole)
Yeager #1	98.63	0.65	0.41	0.06	0.18	0.02	0.03	0.01	1.36	151	0.36
Yeager #6	96.61	1.27	0.68	0.09	0.79	0.10	0.21	0.25	3.15	76	0.12



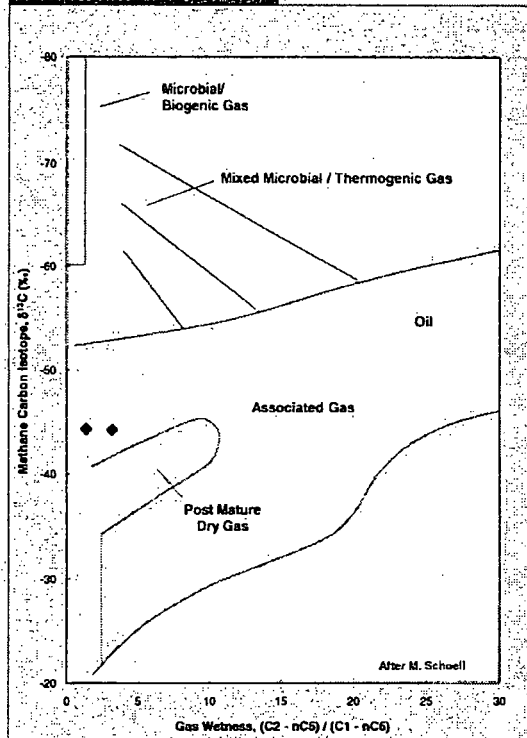
GAS COMPOSITION AND ISOTOPE ANALYSES

GEOMARK RESEARCH LTD.

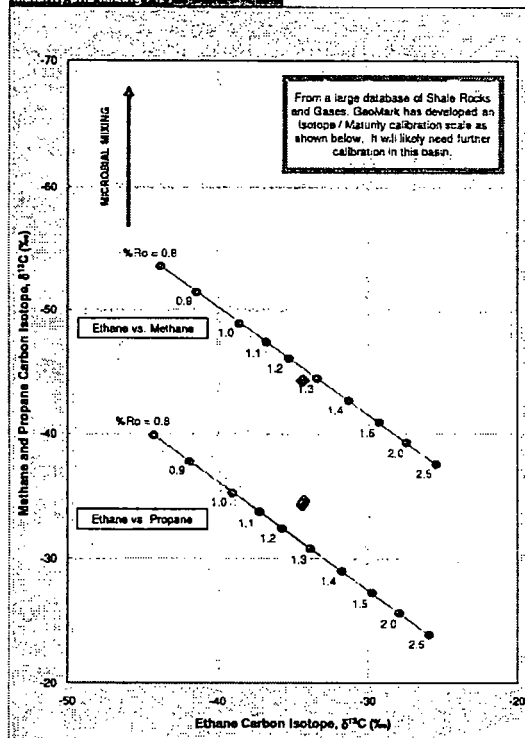
Yeager Property, PA

Gas Analyses

Genetic Gas Classification



Maturity and Mixing Plot



Deuterium Isotope Fingerprinting

